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Enhancing practical skills of TVET students using mathematics as a tool: A case study in some selected TVET schools in Kwahu

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ABSTRACT

Ghana, a developing nation, is no exception to the growing global popularity of technical and vocational education and training (TVET) education. However, the idea of making TVET more applicable and work-oriented in Ghana has only been briefly considered. This investigation examines how mathematics is used as a tool to enhance the practical skills of TVET students. 316 respondents, consisting of 234 males and 82 females, were chosen as the target group by a straightforward random selection procedure. Using the purposive sampling technique, second-year students from three TVET institutions in Kwahu were chosen as the target respondents. For the purpose of investigation, an exploratory survey approach was utilized. Typically, questionnaires were administered to a sample of students at a specific period in order to record their attitudes, beliefs, actions, perceptions, or qualities for descriptive analysis. The data-collection techniques employed in this study, which concentrated on aspects including TVET students' attitudes toward mathematics (ATTI), TVET students' interest in mathematics, and TVET students' practical skills, were modified from those used in earlier studies conducted by other researchers. The acquired data was examined making use of Amos version 23's structural equation modeling software. The study's findings showed that TVET students' attitudes about mathematics significantly influenced their interest in the subject. The outcomes also revealed that ATTI had a positive effect and were statistically significant for their practical skills.

Keywords: TVET students' attitudes toward mathematics, TVET students' interest in mathematics, students practical skills

INTRODUCTION

Numerous circumstances as well as issues in everyday life can be solved practically and with high relevance using mathematics. Therefore, it is a crucial and required subject in many school systems (Mundia, 2010). Mathematics is a foundational subject at all educational levels in Ghana, and the Ministry of Education lists it as one of the essential abilities for the 21st century as well as an indicator of achievement. However, technical and vocational education and training (TVET) schools only pay a minimal amount of attention to mathematics. Mathematics is a key component in enhancing practical abilities, even though it is not listed as a prerequisite for any courses offered in TVET universities. In TVET, mathematics is vital for enhancing students' practical skills (PRASK). However, the majority of TVET students have noticed that accepting mathematical knowledge might be challenging. This argument is supported by a fact that TVET primarily deals with acquiring skills and expertise for the workplace, making it possible for students to create more prospects for effective tasks, financially viable careers, independence, and socioeconomic headway, according to Maclean and Wilson (2009), cited by Kongombe (2012).

In countries like Ghana, the foremost objective is to improve the standard of instruction and students' achievements, particularly since learning outcomes are closely linked to the quality of education provided. Consequently, this directly affects how things evolve in expansion of the economy, as higher quality education fosters it. According to Dike (2006), TVET is a well-planned program that commences with career exploration, supports standard academic and life abilities, and facilitates achieving high academic excellence, leadership, preparedness for industrial labor, advanced and ongoing education. Afeti (2019) believes that the best way to acquire usable skills to compete in the African economy is through TVET.

Ghana introduced TVET education in the year 2000 with the goal of contributing to the growth of a productive pool of workers that is matched to the needs of the economy with the educational system. The purpose of TVET in Ghana, as per UNESCO's 2016 mission statement, is to instill in young people the practical abilities needed to improve their livelihoods, as well as to provide fair accessibility to proficiency-based instruction. Is TVET intended to train young people for a range of jobs or more widely for citizenship and employability? Educationalists claim that TVET credentials "are overly limited, task-focused, and bound to certain

vocations, and have had their educational integrity stolen" (Wheelahan, 2015), while business diplomats, as mentioned by Rageth and Renold (2020), assert that occupational credentials must convene employers' requirement and serve as the foundation for a trained workforce and professional advancement. As a result, there is a natural conflict between the logic of business and that of education in TVET curricula. The relationship (or lack thereof) between theory (represented by academic topics) and practice (represented by learning through practice and work-based) is a clear indication of this tension. In order to provide a knowledge base for TVET education, Ryle (2009) argued for the separation of academic knowledge and practical knowledge. The question of the link among the two categories, however, has not received enough attention (Winch, 2013).

Mathematical thinking and communication are crucial tools in producing goods and services, and technology in the workplace often exceeds human capabilities (FitzSimons, 2002). The aim of teaching and developing mathematical skills in both educational and professional settings is to reach a desired outcome, such as solving real-world problems. It is crucial to prioritize practical training in mathematics for self-sufficiency, as it provides a strong foundation for mental skills and professional discipline. According to Algani (2022), mathematics is the key subject in reaching this goal. The primary mission of teaching mathematics in TVET is to impart knowledge that fosters mental skills and professional discipline (Maron, 2016).

The degree of students' mathematical proficiency and the qualifications they pursued have come under fire within TVET institutions (Wolf, 2011). The goal of studying mathematics in TVET institutions is to meet context and practical needs, but this goal is at odds with the academic pathways' extensive understanding of mathematics and value placed on general understanding (Ernest, 2004). Although TVET has a great deal of promise to advance Ghana's economy, there is still much that needs to be done to make TVET and skill development the engine of Ghana's advancement and growth in the economy. It is essential to think about how to apply mathematics so as to enhance the practical abilities of TVET students in Ghana.

Experts frequently point to the disregard for TVET as the gap in Ghana's industrial development (Nsiah-Gyabaah, 2007). The training content is out-of-date at certain point, and the hallmark of instruction and enlightenment has undyingly deteriorated, despite TVET being acknowledged as a crucial subsector for Ghana's industrial development. It is believed that if Ghana is to accomplish the commercial development objectives outlined in the vision 2020 strategy, it must pay special fixation throughout all stages of education, focused on TVET in order to see any significant results. This critical study focuses on how much practical content aids in competence transitions.

Many TVET learning institutions, particularly polytechnics, struggle to produce graduates who are prepared adequately with practical skills by fusing academic instruction with hands-on experience. The idea of making TVET more useful and practical oriented for work in Ghana has, however, only been briefly discussed. Ghana's TVET schools fall short in terms of giving their graduates the necessary practical skills. For the purpose of enhancing TVET students' practical abilities, this research aims to provide greater understanding in addressing the fragmented natures of the mathematics content, pedagogy, and quality of examinations.

The study's primary goal is to employ mathematics as a means to enhance the practical skills of TVET students in Ghana. The goal of the research is to examine whether the restructuring of the mathematics curriculum and content in Technical and Vocational Institutions in Ghana has been successful.

Research Questions

1. What is the attitude of TVET students in mathematics on their practical skills?
2. What is the attitude of TVET students on their mathematics interest?
3. Does students mathematics interest affect their practical skills?
4. What is the mediating effect of students mathematics interest on the relationship between their attitude towards mathematics and their practical skills?

Theoretical Background & Literature Review

The study's theoretical underpinnings and literature review are based on the need-based theory of McClelland, which guided the study's direction and helped define its objectives, the componential theory, which supports McClelland's theory as well, and APOS (action-process-object-schema) theory of Dubinsky, which places emphasis on radical constructivism and discusses how mathematical concepts can be both "processes" and "objects".

McClelland concentrated on the three internal requirements namely; need for achievement, need for power, and need for affiliation. The theory of McClelland was chosen for this research because its core concepts is feasible to be operationalized in view of the fact that these concepts are universal (Bataeva, 2018). The three needs identified by McClelland were used in this research to operationalize motivation. Additionally, his study findings are recognized as a content-oriented paradigm, which focuses on human needs and explains the various variables that either encourage or restrain an individual's behavior (Erasmus, 2018).

According to Kessler (2013), a few intra-individual elements will eventually combine to produce ingenuity; for this reason, the components were deemed significant for this inquiry. Originality is more likely to occur, according to the componential theory when a person's abilities intersect with their most compelling inherent desires and most ardent pride. The social environment is important to this research because it influences internal and external motivation as well as the connection between invention and creativity. This procedure demonstrates that extrinsic motivation that is constructive does indeed increase intrinsic drive. But whether this process will work well together depends on three key factors: the person's starting level of motivation, the kind of external motivator applied as well as the frequency of the extrinsic motivation.

APOS as a theoretical cornerstone is a constructivism model, which focuses on the idea that individuals typically view mathematical challenges through the building of conceptual behaviors, procedures and components and organize them into concepts to make meaning from scenarios and overcome difficulties (Dubinsky & McDonald, 2008). Based on a study by Dubinsky and McDonald (2001), learning activities should be created to help students build these mental structures in their minds after identifying the likely mental structures for a specific idea.

Empirical Knowledge of Variables Under Study

The relationship between the purpose of the research questions created on the variable being examined, namely, TVET students' attitudes toward mathematics (ATTI), relationship between TVET students' attitudes and students' interest in mathematics and the application of mathematics to students' related practical skills, has led to the division of the empirical evidence into three categories.

TVET students' attitudes toward mathematics

The concept of "attitude" refers to someone's conditioned propensity to reply positively or adversely to a thing, incident, idea, or other person. According to Joseph (2013), it is seen as a belief that people have, which conveys their thoughts and feelings and at times manifests in their conduct. People's conduct toward objects, circumstances, and other people is influenced by their attitudes since attitudes, action, and feelings are all interconnected.

Syyeda (2016) asserts that attitude is multimodal. It considers affection, cognition, and behavior as three factors. Emotions, worldview, and beliefs all contribute to affection. Cognition is a representation of how students view the value of the subject. Contrarily, conduct is related to students' motivation for acquiring knowledge, which is seen in their manner, commitment, and in-class behavior.

These elements are used to gauge the following characteristics of the student's attitude toward mathematics:

1. self-confidence, anxiety, enjoyment (affection)
2. perceived usefulness (cognition)
3. intrinsic motivation (behavior)

Relationship between TVET students' attitudes & TVET students' interest in mathematics

Professionals have focused a lot of attention on how students feel about mathematics (Goldin et al., 2016). According to Mullis et al. (2020), students that approach mathematics positively typically enjoy it, which may result in great performance. However, students are more prone to hate mathematics if they have a bad attitude about the subject, think of it as pointless, and avoid it (Chouinard et al., 2007). In consequence, we can presume that a student's attitude and interest are related in mathematics. As a result, mathematical skepticism among students can be a reliable indicator of their interest in the subject. More recently, it was discovered in the Thai Province of Songkhla that students' attitudes about learning mathematics and their interest as well as achievement were positively correlated (Khun-Inkeeree et al., 2016). As a result, a key factor that may affect students' success is their attitude toward mathematics.

Application of mathematics to students' related practical skills

Mathematical concepts are frequently abstract in nature, making it challenging for students to fully comprehend them. Tasks that allow students to apply these ideas to realistic practical lessons might increase representations of these ideas and promote better understanding. In general, students learn more effectively as soon as they can connect a new subject to one, that they already understand (Richland et al., 2007). When it comes to mathematics, this is especially accurate. The theory of mathematics known as realistic mathematics education (RME) is based on this idea. Since the 1970s, RME has supported mathematics instruction in the Netherlands, and it has also been successfully used in the US and the UK (Van den Heuvel-Panhuizen & Drijvers, 2020). To enable students to comprehend how crucial and important the mathematics they are studying is, it is expedient in RME to pose issues to which they can relate (Van den Heuvel-Panhuizen & Drijvers, 2020). This trait will promote learning during these cross-disciplinary lessons and may increase student interest in what they are learning.

Conceptual Framework

The main features of the study's framework are the attitudes of TVET students coupled with the interest of TVET students towards the learning of mathematics in enhancing learners' knowledge to related practical skills (**Figure 1**).

Any effort to develop applicable teachings in a lasting way must acknowledge and consider the integration of mathematics in TVET classroom. The structure of a conventional TVET education system would need to be significantly changed in order to move away from classes that are specialized in one area. Additionally, it is advised that mathematics teachers' pay close attention to the learning objectives and progressions that are particular to the subject in order to avoid undermining students' progress in these disciplines (Tytler et al., 2019).

Mathematics should not only be utilized in practical courses as a means of facilitating the completion of tasks, and practical lessons should not be seen as a way of giving mathematical concepts a helpful context. Opportunities to blend prior knowledge from mathematics and practical classes also enables a student's learning route to continue logically, as advised by the updated Bloom's taxonomy described in Anderson et al. (2001). The structure for such experiences is established by integrating transdisciplinary lessons into single topic training, which establishes foundational learning.

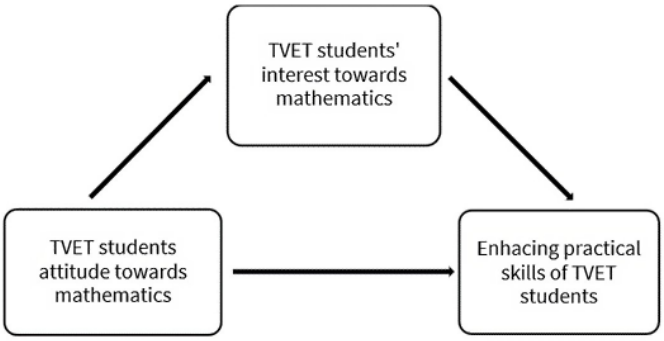

Figure 1. Conceptual framework (Source: Authors' own elaboration)

This approach should result in improved learning retention as interleaving was shown to significantly influence student retention in mathematics by Rohrer et al. (2020). Similar to how students are revisiting materials they already comprehended or interacted with, the continued application of previously learnt material throughout time (distributed practice) is an intrinsic part. As a result, lessons that integrate mathematics must be used in addition to sessions that focus on a single subject to guarantee that students have a firm knowledge base and understanding in each discipline before attempting to combine content from two.

MATERIALS & METHODS

Population, Sample, & Collection of Data

The study focuses on TVET students from three specifically chosen TVET schools in Kwahu, in Ghana's Eastern Region. The participants in the study's population comprised 1,500 second-year TVET students from three TVET schools chosen. A variety of learning styles were represented in the courses offered by each of the selected TVET institutions. The academic, social, and economic backgrounds of mathematics students were also investigated and taken into consideration. Using a targeted selection technique, students who studied fashion and design technology, building and construction technology, mechanical engineering technology, and electrical engineering technology were selected In an approach taken by Miller and Brewer (2003), a method of determining sample size was used for this investigation, as shown in Eq. (1):

$$n = \frac{N}{1+N\alpha^2}, \tag{1}$$

where *N* is the population size (1,500), *n* is the sample size, and α is the significance level (0.05). A 95% confidence interval and a 5.00% margin of error were used to determine the sample size because the study's focus was on human respondents, whose responses could be biased.

Pursuant to the formula, a total sample size of 316 students were chosen from the three TVET schools in Kwahu, as calculated in Eq. (2):

$$n = \frac{1{,}500}{1+1{,}500\times 0.05^2}, \tag{2}$$

Since it was crucial to comprehend the respondent's responses to the research questions by looking at the findings, a questionnaire was utilized in this study to collect data (Mertens, 2014). The survey, which was adapted from an existing instrument, was developed to collect data on characteristics crucial to the study. The quantitative data analysis is considered when analyzing the data for this inquiry. Using a quantitative technique, the survey's quantifiable data were examined. Using Amos version 23, structural equation modeling was completed. Utilizing SPSS (v. 23) computer application, data from closed-ended questions was coded and entered. The data that was gathered and the conclusions of this investigation allow for generalization and result predictions.

Measures & Questionnaire

The researcher was able to quickly gather data from a large number of respondents while upholding anonymity and confidentiality thanks to the usage of questionnaires. ATTI, TVET students' interest in mathematics (SMN), and TVET students' practical skills (PRASK) were the study's key variables. To precisely quantify viewpoints and opinions, the technique makes use of five-point Likert scales. From "SA" (strongly agree) at a value of five to "SD" (strongly disagree), at a value of one, these scales are available. Due to the fact that it allowed respondents to say how much they agreed or disagreed with a collection of statements about their beliefs on a certain topic, this particular scale had a history of accurately assessing thoughts and opinions. A small-scale pilot study was conducted during the data collection phase to ensure quality assurance. The pilot study cut out extraneous language and distinguished between comparable items with clear distinctions. Cronbach's alpha (CA) for each latent variable was also found to be more than 0.7 using SPSS (v. 23), demonstrating that a certain level of internal consistency had been obtained. A CA score of 0.957 was obtained for TVET students' attitude toward mathematics, 0.841 for their interest in mathematics, and 0.907 for their practical skills.

Table 1. Confirmatory factor analysis

Variable	Standard factor loadings
Attitude of TVET students in mathematics (ATTI): CA=.957; CR=.957; & AVE=.882	
ATTI1: Mathematics has no usefulness in TVET courses.	.931
ATTI2: I cannot study mathematics no matter how I try.	.942
ATTI8: I am always lost in thought during mathematics lessons.	.94
TVET students' interest in mathematics (SMN): CA=.841; CR=.843; & AVE=.575	
SMN7: The way mathematics is taught make me love the subject.	.735
SMN8: I hate to miss mathematics lessons.	.687
SMN9: Mathematics is useful in many aspects of life.	.835
SMN10: I believe I can do mathematics.	.769
Practical skill of TVET students (PRASK): CA=.907; CR=.900; & AVE=.691	
PRASK4: Mathematics do not promote real-world practical skills.	.809
PRASK6: Knowledge in mathematics do not guarantee success in practical skills.	.877
PRASK7: Mathematics has no usefulness in my practical skills.	.824
PRASK9: Using practical skills in a course work do not need mathematics.	.814

Note. Model fitness: CMIN=79.718; df=40; CMIN/df=1.993; TLI=.978; CFI=.984; RMSEA=.056; RMR=.0495; & PClose=.263

The number of indicators with incorrect construct loadings or loading values below 0.5 was also reduced or eliminated using the exploratory factor analysis (EFA). Out of all the loaded observable variables, item 8 "I am always lost in thought during mathematics lessons" had the highest mean score (mean [M]=3.2109 and standard deviation [SD]=1.31325) for indicators under the attitude of TVET students in mathematics. As a result of adopting a positive outlook on mathematics, PRASK actually increase. Item 1: "mathematics has no usefulness in TVET courses" had the lowest mean (M=3.0735 and SD=1.29510). 1.25305 is the standard deviation and 3.1448 is the overall mean for this indicator. In SMN category, item 7– "the way mathematics is taught makes me love the subject"–had the lowest mean. As for question 9, "mathematics is useful in many aspects of life," the highest mean score was found for this item (M=3.4441 and SD=1.33250). Item 10, "I believe I can do mathematics," was found to have M=3.8243 and SD= 1.20007. Another item that was examined by the respondents and verified with M=3.5719 and SD=1.16662 was "I hate to miss mathematics lessons." The overall mean score for PRASK was 3.2572, with SD= 1.27670. SD=1.50131 and the mean score was 3.2173 for the statement "mathematics has no usefulness in my practical skills." This indicator has the lowest mean score, whereas the highest mean score among all the indicators under PRASK is "mathematics do not promote real-world practical skills" (M=3.2971 and SD=1.41576). With a mean of 3.2907 and SD= 1.43953, the indicator "knowledge in mathematics does not guarantee success in practical skills" was found to be the second highest among the rest. The range of these mean scores is 3.2 to 3.3.

Validity & Reliability Analysis

To make sure that all pertinent information was recorded, careful attention was paid to each participant's responses. Each participant actively participated during the whole data gathering process, which helped to establish the study's credibility. The dependability of a study is established by the researcher's technique and methods, as well as by whether the findings were duplicated with similar participants under comparable conditions (Kosh, 2006). In this case, CA reliability test was applied, and its reliability coefficient of 0.05 was deemed sufficient to support using these instruments for the inquiry. Confirmatory factor analysis (CFA) was analyzed with the use of Amos version 23 statistical package. The retained measurement items from EFA were utilized to assess the model fitness of the study data. CFA's primary goal was to ascertain whether the study data fit for further data analysis. According to EFA, the determinant's coefficient was determined to be 0.567, and the three latent variables also indicated a cumulative variance of 78.75%. According to Bamfo et al. (2018), CFA model fit based on the following conditions: TLI and CFI must be at least 0.9, RMEAS and RME must be less than 0.08, and CMIN/df must be less than three and PClose must be statistically insignificant (p-value>0.05). From **Table 1**, attitude of TVET students in mathematics had three indicators with average extracted variance (AVE) was 0.882, CA was 0.957, and composite reliability (CR) was 0.957. Additionally, SMN had four indications with values for CA, CR, and AVE of 0.841, 0.843, and 0.575, respectively. On top of that PRASK indicator had four indicators with values of 0.691 for AVE, 0.900 for CR, and 0.907 for CA.

Path Analysis

The hypothesis of the study was tested with the used of Amos version 23 statistical package. The current study make use of one dependent variable, one mediator, and one independent variable (**Figure 2**).

Table 2 shows path analysis summary. From **Table 2**, gender and age of the respondents had a negative and insignificant impact on practical skills of TVET students with (β=-.198 and CR=-.1665) and (β=-.120 and CR=-1.273), respectively. In addition, level of the students had a positive and significant impact on practical skills of TVET students (β=2.453 and CR=2.670). Moreover, program of study had a negative impact but significant on practical skills of TVET students (β=-.343 and CR=-7.115).

Figure 3 shows path analysis diagram.

Research Question 1: What is the Attitude of TVET Students in Mathematics on Their Practical Skills?

The effect of attitude of TVET students in mathematics on their practical skill in was analyzed by (ATTI→PRASK). From the analysis results in **Table 2**, ATTI had a positive impact and statistically significant on their practical skills with a p-value less than 1.00% (β=.405 and CR=8.350). According to the findings, the practical skills of TVET students were positively impacted by their attitude toward mathematics by 40.50%.

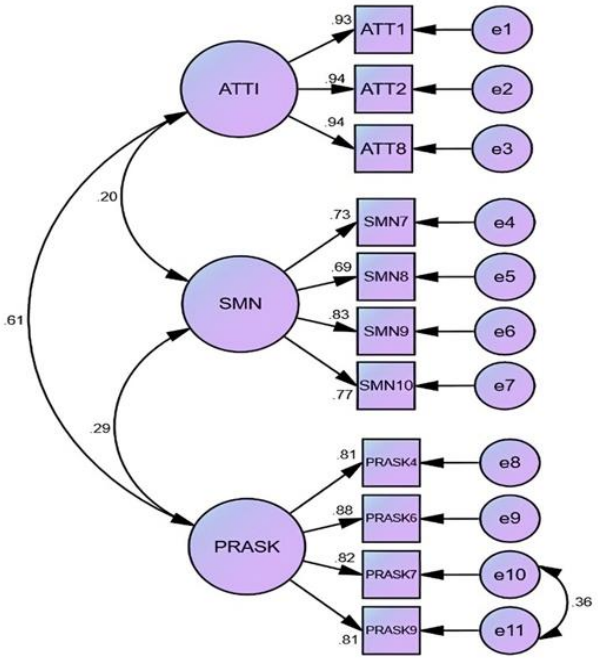

Figure 1. Confirmatory factor analysis (Source: Authors' own elaboration)

Table 2. Path analysis summary

Direct effect	Standard estimate	Standard error	Composite reliability	p-value
Gender→PRASK	-.198	.119	-.1665	.096
Age→PRASK	-.120	.094	-1.273	.203
Level→PRASK	2.453	.919	2.670	.008
Program→PRASK	-.343	.048	-7.115	.000
ATTI→SMN	.147	.047	3.154	.002
ATTI→PRASK	.405	.049	8.350	.000
SMN→PRASK	.286	.067	4.284	.000
Indirect effect	**Standard estimate**	**Lower bound**	**Upper bound**	**p-value**
ATTI→SMN→PRASK	.114	.048	.185	.004

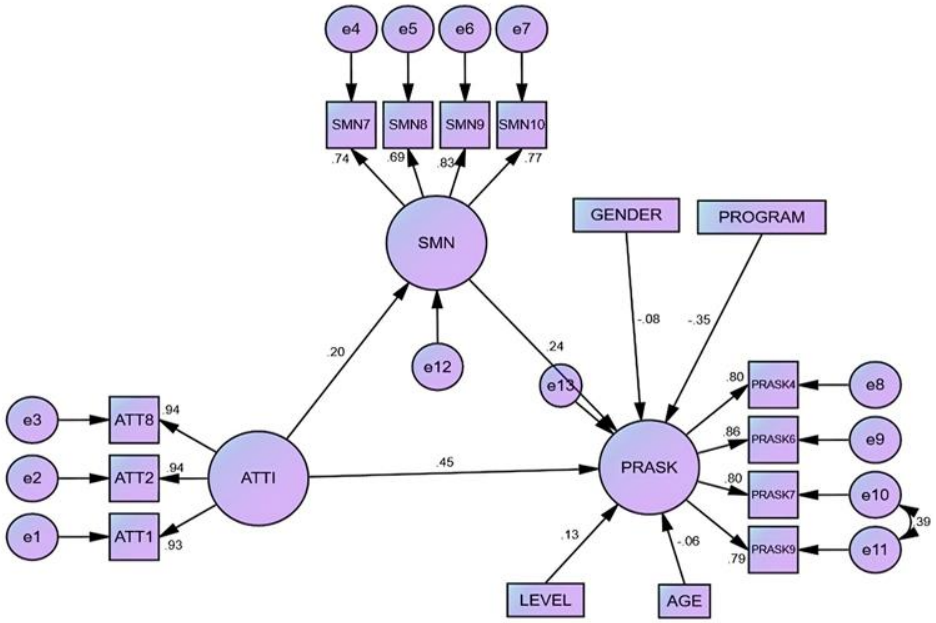

Figure 3. Path analysis diagram (Source: Authors' own elaboration)

Research Question 2: What is the Attitude of TVET Students in Mathematics on Their Mathematics Interest?

The effect of attitude of TVET students in mathematics on students' mathematics interest was analyzed by (ATTI→SMN). From analysis in **Table 2**, ATTI has a positive and significant impact on their mathematics interest with a p-value less than 1.00% (β=.147 and CR=3.154). The result further explains that there was 14.70% positive impact of ATTI on their mathematics interest.

Research Question 3: Does Students Mathematics Interest Affect Their Practical Skills?

The research question three seek to determine whether students' mathematics interest has effect on their practical skills. The direct effect of TVET students' mathematics interest on their practical skills was analyzed by (SMN→PRASK). The analysis result in **Table 2** shows that the interest in mathematics among TVET students was positively correlated and statistically significant on their practical skills with a p-value less than 1.00% (β=.286 and CR=4.284). The analysis result shows that, TVET students' mathematics interest has 28.80% significant impact on their practical skills.

Research Question 4: What is the Mediating Effect of Students' Mathematics Interest on Relationship Between Attitude of TVET Students in Mathematics and Their Practical Skills?

Research question four sought to determine the mediating outcome of TVET students' mathematics interest on the relationship between TVET students' attitude towards mathematics and their practical skills. To determine the mediating outcome of TVET student's mathematics interest, the research first determine the direct effect of TVET students' attitude towards mathematics on their practical skills and it was positive and statistically significant (β=.045***). Additionally, as shown in **Table 2**, the impact of TVET students' attitudes about mathematics on their interest in mathematics was discovered to be favorable and statistically significant (β=.147***). Also, the effect of TVET students' mathematics interest on their practical skills was positive and statistically significant (β=.286***). Since both lower and upper BCs were positive, indirect effect on PRASK (ATTI→SMN→PRASK) was statistically significant (coefficient=.114). This but only has a partly mediating effect because practical skills of TVET students were directly positively impacted by students' attitude toward mathematics, which was statistically significant

DISCUSSION

It was determined that learning mathematics had a substantial impact on the practical skills of second-year students in three chosen TVET schools in Kwahu among TVET students sampled for the study. The majority of previous research on mathematics education has concentrated on grammar schools, with relatively little focus on TVET institutions. As a result, this research broadens our understanding of mathematics instruction in TVET institutions. For instance, Akinoso (2011) claimed that students learn mathematics more actively and effectively when they show a significant interest in the subject. The results showed that ATTI had a favorable impact and were statistically significant on their practical skills. This accounted for a 40.50% positive effect on TVET students in relation to their practical skills. A great deal of the students in this study believed that their TVET courses and the study of mathematics were two different things. However, mathematics generally became more pertinent, significant, and rational when it was linked to students' acquisition of practical skills. The emergence of operational mathematics as an applicable topic in TVET portrayed an alteration in viewpoint that positively impacted the way pupils connected with mathematics. Despite the fact that students still only gave a modest amount of attention to the practical components of their courses of study (Hodgson & Spours, 2008) while only identified a few practical applications for mathematics (Ernest, 2004), students continue to emphasize the hands-on aspects of their studies. According to the analysis, linked mathematics instructional methods in TVET can help students cross some of these gaps with the inclusion of mathematics as a discipline that can include both academic knowledge and practical skills. In addition to highlighting the significance of common goals in mathematics classrooms for TVET students, this study's connected instructional methodology mirrors several embedding ideas from earlier research (Eldred, 2005). The findings of this study demonstrated that ATTI had a substantial impact on their interest in mathematics. A study by Mullis et al. (2020) supported the idea that students who have a good attitude toward mathematics likely to be interested in the subject, which could result in great performance. However, students who have a bad attitude about mathematics often despise and think little of the subject. As a result, it is established that students' attitudes and interest in mathematics are related. The findings of this study also demonstrated that students' interest in mathematics served as a mediator between the direct and indirect effects of mathematics on their practical skills in TVET. Lazarides and Buchholz (2019) discovered that certain students' performance was influenced by the quality in mathematics education. In a similar vein, Fauth et al. (2019) discovered that student interest was significantly influenced by the quality of the teacher's instruction in science education. These links allowed for a type of "boundary crossover" that helped students resolve some tensions between their practical skills and their mathematics study. These approaches offer ways in which more integration and more involvement can be introduced into the student perspective while studying mathematics in TVET institutions, notwithstanding the basic gaps that still exist between the methods of instruction for mathematics and practical skills. Moreover, in comparison with earlier research conducted among Asian secondary school students, research indicates that Asian students may harbor negative attitudes about mathematics as a result of advocates such parents and teachers (Mullis et al., 2020). They put pressure on students to study harder and do well on exams, which makes them become less enthusiastic about mathematics. Nonetheless, more investigation is necessary to confirm the results of this study.

CONCLUSIONS

The investigation's findings indicates that TVET students' attitude in mathematics have a positive impact and statistically significant on their practical skills with a p-value less than 1.00% (β=.405 and CR=8.350). The results indicate that, there was 40.50% positive effect of TVET students' attitude in mathematics on their practical skills. Additionally, TVET students' attitude on mathematics has a positive and significant impact on their mathematics interest with a p-value less than 1.00% (β=.147 and CR=3.154). The result further explains that there was 14.70% positive impact of TVET students' attitude towards mathematics on their mathematics interest.

Mathematical knowledge, however, is more pertinent, meaningful, and coherent when it is linked to PRASK development. While students continued to place a strong emphasis on their practical skills, their acceptance of functional mathematics as a subject that is relevant to their careers will mark a change in their viewpoint to enhance their interest in the subject. This emphasizes the significance of building and upholding favorable attitudes toward mathematics among TVET students. The analysis of the study showed that, TVET students' interest in mathematics had a direct positive impact and statistically significant on their practical skills with a p-value less than 1.00% (β=.286 and CR=4.284). In this regard, the practical skills of students can be enhanced when students have interest in Mathematics and can as well link to their practical lessons. Also, in evaluating how TVET students' attitude toward mathematics and their practical skills is connected, it was discovered that TVET students' attitude toward mathematics had a positive and statistically significant effect on their interest in mathematics (β=.147***). By teaching mathematics as a subject that is not limited to the realm of academic knowledge but can also constitute practical linked skills, connected mathematics classroom practices in TVET can help students to overcome some of these divides. The connected classroom approach emphasizes the value of shared values and compatible cultures in mathematics courses for TVET students, while also reflecting some of the embedding ideas from earlier research (Eldred, 2005). Furthermore, ATTI had a favorable and statistically significant impact on their practical skills (β=.045***). Likewise, TVET students' interest in mathematics had a favorable and statistically significant (β=.286***) impact on their practical skills. The study found that TVET students' interest in mathematics had a partial mediation influence on their practical skills since their attitude toward mathematics also had a direct positive effect and was statistically significant. It can therefore be confidently emphasized that when the teaching and learning of mathematics is efficiently and effectively done in TVET schools, the practical skills of the students in said schools will be greatly enhanced. Students will benefit from this as they become more prepared for careers in engineering, sewing, woodworking, construction, and even agriculture–all of which rely significantly on mathematics. The consensus is that TVET may provide both genders with useful skills that increase their confidence and independence. Consequently, it is seen as a means of advancing industrial development, skill development, and human resource expansion. TVET should therefore be viewed as a remedy for the country's ever-escalating poverty issue. It is vital to ensure that TVET programs are excellent and relevant to the needs and aspirations of our community, and that all Ghanaians have equal access to them.

Recommendations

The research's conclusions point to the following recommendation:

1. To enhance the practical skills of TVET students, it is recommended that stakeholders in TVET institutions to gear the study of and instruction in mathematics towards students' practical lessons.
2. There must be recurring, cooperative policy evaluations between universities, polytechnics, and the government to improve the substance of the mathematics curriculum.
3. The emphasis on practice should take precedence over theory in the mathematics curriculum.
4. To ensure that the results are representative of Ghana, a significantly larger sample size is advised from the demarcated 16 regions.

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REFERENCES

Afeti, G. (2019). *The importance of TVET in Africa's socio-economic development*. https://africapolicyreview.com/the-importance-of-tvet-in-africas-socio-economic-development/

Akinoso, S. O. (2011). Correlates of some factors affecting students achievement in secondary school mathematics in Osun State, Nigeria. *International Journal of Education, Science, Mathematics and Environmental Studies, 3*(1), 83-95.

Algani, Y. M. (2022). Role, need and benefits of mathematics in the development of society. *Journal for the Mathematics Education and Teaching Practices, 3*(1), 23-29.

Anderson, L., Krathwohl, D., Airasian, P., Cruikshank, K., Mayer, R., Pintrich, P., Raths, J., & Wittrock, M. (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy*. Longman Publishing.

Bamfo, B. A., Dogbe, C. S. K., & Osei-Wusu, C. (2018). The effects of corporate rebranding on customer satisfaction and loyalty: Empirical evidence from the Ghanaian banking industry. *Cogent Business and Management, 5*(1), 1413970. https://doi.org/10.1080/23311975.2017.1413970

Bataeva, E. V. (2018). Motivational content analysis of primary school textbooks on literature in context of D. McClelland's theory. *The Educational and Science Journal, 20*(1), 136-151. https://doi.org/10.17853/1994-5639-2018-1-136-151

Chouinard, R., Karsenti, T., & Roy, N. (2007). Relation among competence beliefs, utility value, achievement goals and effort in mathematics. *British Journal of Educational Psychology, 77*(3), 501-517. http://doi.org/10.1348/000709906x133589

Dike, V. E. (2006). *Educational Review Committee's report from 1957-2007*.

Dubinsky, E., & McDonald, M. A. (2001). *APOS: A constructivist theory of learning in undergraduate mathematics education research. The teaching and learning of mathematics at university level: An ICMI study.* Kluwer Academic Publishers.

Eldred, J. (2005). *Developing embedded literacy, language and numeracy: Supporting achievement*. NIACE.

Erasmus, B. (2018). *Human resourses management and South African labor legislative framework. Introduction to business management*. Oxford University Press.

Ernest, P. (2004). *Relevance versus utility.* National Center for Mathematics Education.

Fauth, B., Decristian, J., Decker, A., Buttner, G., Hardy, I., Klieme, E., & Kunter, M. (2019). The effects of teacher competence on student's outcome in elementary science education: The mediating role of teaching quality. *Teaching and Teacher Education, 86*, 102882. https://doi.org/10.1016/j.tate.2019.102882

FitzSimons, G. E. (2002). *What counts as mathematics? Technologies of power in adult and vocational education*. Kluwer Academic Publishers. https://doi.org/10.1007/0-306-47683-5

Goldin, G. A., Hannula, M. S., Heyd-Metzuyanim, E., Jansen, A., Kaasila, R., Lutovac, S., & Zhang, Q. (2016). *Attitudes, beliefs, motivation and identity in mathematics education: An overview of the field and future directions*. Springer. https://doi.org/10.1007/978-3-319-32811-9

Hodgson, A., & Spours, K. (2008). *Education and training 14-19: Curriculum, qualifications and organization*. SAGE. https://doi.org/10.4135/9781446220955

Joseph, G. (2013). *A study on school factors influencing students attitude towards learning of mathematics in the community secondary schools in Tanzania: The case of Bukoba Municipal Council in Kagera Region*. http://www.repository.out.ac.tz/919/

Kessler, E. H. (2013). *Encyclopedia of management theory*. SAGE. https://doi.org/10.4135/9781452276090

Khun-Inkeeree, H., Omar-Fauzee, M. S., & Othman, M. K. H. (2016). The mathematics performance of primary school students' in Southern Thailand. *International Journal of Academic Research in Progressive Education and Development, 5*(3), 41-51. https://doi.org/10.6007/IJARPED/v5-i3/2208

Kongombe, C. (2012). *Lessons for developing countries from experience with technical, vocational education and training*. International Growth Center.

Kosh, T. (2006). Establishing rigour in qualitative research: The decision trail. *Journal of Advanced Nursing, 53*, 91-100. https://doi.org/10.1111/j.1365-2648.2006.03681.x

Lazarides, R., & Buchholz, J. (2019). Students-perceived teaching quality: How is it related to different achievement emotions in mathematics classrooms? *Learning and Instruction, 61*, 45-59. http://doi.org/10.1016/j.learninstruc.2019.01.001

Maclean, R., & Wilson, D. (2009). *International handbook of education for the changing world of work*. Springer. http://doi.org/10.1007/978-1-4020-5281-1

Maron, I. A. (2016). Priorities of teaching mathematics in university. *International Electronic Journal of Mathematics Education, 11*(9), 3339-3350.

Mertens, D. M. (2014). *Research and evaluation in education and psycology*. SAGE.

Miller, R. l., & Brewer, J. D. (2003). *The AZ of social research: A dictionary of key social science research concept*. SAGE. https://doi.org/10.4135/9780857020024

Mullis, I. V., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMMS 2019 international results in mathematics and science* [Paper presentation]. The TIMMS & PIRLS International Association for the Evaluation of Educational Achievement.

Mundia, L. (2010). Problems in learning mathematics: Comparison of Brunei junior high school students in classes with and without repeaters. *Journal of Mathematics Research, 2*(3), 150-160. https://doi.org/10.5539/jmr.v2n3p150

Nsiah-Gyabaah, K. (2007). The missing ingredients in technical and vocational education in meeting the needs of society and promoting socio-economic development in Ghana. *Journal of Polytechnics in Ghana, 3*(3).

Rageth, L., & Renold, U. (2020). The linkage between the education and employment systems: Ideal types of vocational education and training programs. *Journal of Educational Policy, 35*(4), 503-528. https://doi.org/10.1080/02680939.2019.1605541

Richland, L. E., Zur, O., & Holyoak, K. J. (2007). Cognitive supports for analogy in the mathematics classroom. *Science, 316*(5828), 1128-1129. https://doi.org/10.1126/science.1142103

Rohrer, D., Dedrick, R., Hartwig, M., & Cheung, C. (2020). A randomized controlled trial of interleaved mathematics practice. *Journal of Educational Psychology, 112*(1), 40-52. https://doi.org/10.1037/edu0000367

Ryle, G. (2009). *The concept of mind.* Routledge. https://doi.org/10.4324/9780203875858

Syyeda, F. (2016). Understanding attitudes towards mathematics (ATM) using multimodal model: An expository case study with secondary school children in England. *Cambridge Open-Review Educational e-Journal, 3*, 32-62.

Tytler, R., Williams, G., Hobbs, L., & Anderson, J. (2019). Challenges and opportunities for a STEM interdisciplinary agenda. In B. Doig, J. Williams, D. Swanson, R. Borromeo Ferri, & P. Drake (Eds.), *Interdisciplinary mathematics education* (pp. 51-81). Springer. https://doi.org/10.1007/978-3-030-11066-6_5

Van den Heuvel-Panhuizen, M., & Drijvers, P. (2020). Realistic mathematics education. In S. Lerman (Ed.), *Encyclopedia of mathematics education* (pp. 713-717). Springer. https://doi.org/10.1007/978-3-030-15789-0_170

Wheelahan, L. (2015). The future of Australian vocational education qualifications depends on a new social settlement. *Journal of Education and Work, 28*(2), 126-146. https://doi.org/10.1080/13639080.2014.1001333

Winch, C. (2013). Three different conceptions of know-how and their relevance to professional and vocational education. *Journal of Philosophy of Education, 47*(2), 281-298. https://doi.org/10.1111/1467-9752.12025

Wolf, A. (2011). *Review of vocational education–The Wolf report*. Department of Education, London.